# Effects of X-ray Optics on the Visibility of Coherent X-ray Diffraction

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Coherent X-ray diffraction (CXD) provides a non-invasive method of imaging the internal structure of nanoscale crystalline materials. A coherent x-ray diffraction image is obtained when the coherence of an x-ray beam is greater than the spatial dimensions of the object being imaged. In this scenario, the intensity distribution surrounding each Bragg peak of a crystal is the magnitude squared of the three-dimensional Fourier Transform of the shape. The phase information needed to invert the diffraction pattern to obtain an image of the original object is lost but may be recovered using iterative phasing algorithms. The success and accuracy of the inversion depends strongly on the quality of the initial diffraction image. The coherence properties of the incoming x-ray beam play a crucial role in determining whether a diffraction pattern can be inverted.

In coherent x-ray diffraction, the standard constraint is to have the coherence lengths of the x-ray beam be larger than the spatial dimensions of the crystal. These coherence lengths depend on machine parameters but also on the optics in the beam path. The propagation of coherence along this multitude of optics is difficult to quantify and it is hard to ensure that the x-ray beam incident on the sample has the necessary coherence condition to obtain an invertible pattern.

An alternative way of judging the coherence qualities of the beam is to look at the diffraction image itself. The traditional figure of merit for the coherence of a light wave is the complex degree of coherence which measures the degree to which two light waves interfere. This complex degree of coherence is coupled to the visibility of a diffraction image and is a quantity that can be experimentally obtained. By changing the beamline optics, we can alter the coherence properties of the x-ray beam. These changes can be clearly seen in the changing complex degree of coherence but would be difficult to quantify by using the coherence lengths of the source. We present a study of the effect of optical elements in altering the coherence of an x-ray beam by using the coherent diffraction images from gold nanoparticles.